TECHNICAL MANUAL 1003

Guidance on Preparing a Risk Assessment for Air Contaminant Emissions

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation

Revised December 1994

Christine Todd Whitman, Governor
Robert C. Shinn, Jr., Commissioner

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1.0 INTRODUCTION

1.1 Purpose of Document

This document provides information on the requirements of the New Jersey Department of Environmental Protection (NJDEP) Air Quality Permitting Program (AQPP) for carrying out a risk assessment in conjunction with applying for an air pollution control pre-construction permit.

There are different requirements for risk assessment depending on the type of source applying for a permit. Specific requirements are described in this document and its appendices.

1.2 Sources Requiring Risk Assessments

New and modified sources of air pollution which must have an air pollution control pre-construction permit as defined in New Jersey Administrative Code, Title 7, Chapter 27, Subchapter 8 (N.J.A.C. 7:27-8), "Permits and Certificates," are subject to a risk assessment if they emit certain contaminants regarded as air toxics.

As per N.J.A.C. 7:27-8.4(f), "[u]pon request of the Department,...the applicant for a permit shall demonstrate by air quality analysis, including air quality simulation modeling... and risk assessment, whether the maximum controlled emissions stated on the permit application may cause:

1. A violation of any State or Federal ambient air quality standard;

2. Any exceedance of a PSD increment as defined in 40 CFR 52;

3. An increase in ambient air concentration that equals or exceeds the significant air quality effect level, as set forth in Table 1 of N.J.A.C. 7:27-18.4(a), in a nonattainment area for any air contaminant; or

4. A contravention of any other criterion established by the Department to protect human health and welfare and the environment."

For more detail on who is subject to risk assessment, see sections 3.1 and 4.1.

1.3 Risk Assessment Overview

There are two approaches to risk assessment in the Air Quality Permitting Program: **refined risk assessment** and **risk screening**. The type and size of the facility or source determines which approach is used. In a refined risk assessment, described in more detail in Section 3.0, the applicant is required to prepare and provide the risk assessment, after first obtaining approval of a protocol from the AQPP Bureau of Air Quality Evaluation (BAQEv). Risk screening, described in Section 4.0, is done in-house by AQPP staff.

1.4 Definition of Air Toxics

Air toxics are natural or man-made pollutants that when emitted may cause an adverse health effect. Evidence of adverse health effects is based on human and animal exposure studies. This definition generally excludes "criteria pollutants," that is, those for which National or New Jersey Ambient Air Quality Standards have been established. The primary exception to this is lead, which is often included on lists of air toxics because of its ability to cause adverse health effects at extremely low exposures.

The toxic substances (TXS) as listed in N.J.A.C. 7:27-17 are a very small subset of the universe of toxic air contaminants. A broader, but still incomplete, list of air toxics is the Hazardous Air Pollutants (HAPs) list in the 1990 amendments to the federal Clean Air Act (Title III, Section 112(b)(1)). NJDEP's lists of inhalation unit risk factors and reference concentrations (see Appendix A) consist of contaminants whose estimated health effects have been quantified for the inhalation route of exposure. It is these contaminants that are generally considered in the risk assessments described in this document.

2.0 RISK ASSESSMENT COMPONENTS

2.1 Purpose of Risk Assessment

Risk assessment is a scientific process used to estimate the probability of adverse health effects resulting from human exposure to hazardous substances. Risk assessment is utilized in the Air Quality Permitting Program in several ways:

a. To evaluate potential risks remaining after the application of pollution controls (residual risk);

b. To make policy decisions regarding permitting of and/or regulation of toxic substances;

c. To assist local individuals and communities in understanding risk, the risk assessment process, and the risk management decisions made by NJDEP.

2.2 Risk Assessment Steps

In 1986, the U.S. Environmental Protection Agency (USEPA) established risk assessment guidelines in order to provide consistency and technical support between USEPA and other regulatory agencies. The guidelines were based on recommendations from the National Research Council (NRC 1983). NRC divided the risk assessment process into four steps, which NJDEP follows. These steps are described below.

2.2.1 Hazard Identification

Hazard identification is the process used to determine the potential human health effects from exposure to a chemical. This is based on information provided by scientific literature.

For hazard identification in AQPP the following must be determined:

a. What contaminants will be emitted from the source;

b. Which of these contaminants have known health effects;

c. What are the specific toxicological effects of these contaminants.

The contaminants of concern for a source type must be identified by the applicant.

2.2.2 Dose-Response Assessment

Dose-response assessment is the characterization of the relationship between exposure or dose and the incidence and severity of the adverse health effect. It should take into consideration factors that influence this relationship, including intensity and pattern of exposure and age and lifestyle variables that may affect susceptibility. It may also involve extrapolation from high dose responses to low dose responses, and from animal responses to human responses. This information is gathered from epidemiological or laboratory studies done by USEPA, other federal or state agencies, health organizations, academic institutions and others.

Dose-response assessment as utilized by AQPP involves the quantification (in terms of severity or likelihood) of toxicological effects of individual chemicals on humans, usually based on information developed by USEPA. The dose-response relationship is evaluated differently for carcinogenic and non-carcinogenic substances. For carcinogens, it is assumed that there is a linear relationship between a unit increase in dose or exposure concentration and an increase in cancer risk, with no threshold. USEPA has developed **unit risk factors** (URFs) and **slope factors** (SFs) for evaluating risks from these substances. For noncarcinogens, USEPA has developed inhalation **reference concentrations** (RfCs) and oral **reference doses** (RfDs), which represent "a provisional estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a...lifetime..." (USEPA 1994b).

Available dose-response information is thoroughly reviewed and verified by USEPA and then gathered into a database, the Integrated Risk Information System (USEPA 1994a). Additional information is made available in publications such as the *Health Effects Assessment Summary Tables (HEAST)* (USEPA 1994b). BAQEv maintains a list of URFs and RfCs for evaluating inhalation exposure, based on USEPA and other sources of information (see Appendix A).

2.2.3 Exposure Assessment

The exposure assessment step determines the extent (intensity, frequency, and duration) of human exposure to a chemical in the environment. There are three components to exposure assessment in AQPP:

a. Estimation of the quantity of each pollutant emitted from the source of concern (based on data from previously existing sources or engineering estimates).

b. For each contaminant emitted from a source, estimation of the resulting maximum average ambient air concentration, using dispersion models, or nomographs based on dispersion models.

c. Estimation of the amount of contaminant taken in by a human receptor.

Additional considerations include:

a. Exposure routes other than inhalation - such as dermal contact; ingestion of soil, vegetation, fish, water, meat, cow's milk, mothers milk;

b. Air quality deposition modeling - to estimate the concentration of pollutants affecting soil, plants, water, fish and other potential exposure routes;

c. The intensity, frequency and duration of contact with the pollutant in various media;

d. Chemical intake and uptake rates in the environment and the body;

e. Childhood exposures.

2.2.4 Risk Characterization

The final step in risk assessment, risk characterization, calculates and presents the public health risk estimates based on the information gathered in the first three steps. It should also include some consideration of uncertainty, scientific judgement, and the major assumptions that were made, especially regarding exposure.

2.2.4.1 Carcinogens

Public health risk estimates for inhalation of carcinogens are based on the following calculation:

Incremental risk = C x URF

where:
C = maximum annual average ambient air concentration of a pollutant, $\mu g/m^3$
URF = pollutant-specific inhalation unit risk factor, $(\mu g/m^3)^{-1}$

For routes of exposure other than inhalation, risk is calculated by multiplying the chemical dose (in mg/kg/day) by the chemical-specific oral slope factor (in $(mg/kg/day)^{-1}$).

For the types of sources discussed in this manual, AQPP has established the following Risk Management policy:

a. If the incremental cancer risk from any contaminant evaluated is less than or equal to one in one million (1×10^{-6}), the risk is considered negligible.

b. If the incremental cancer risk is greater than or equal to one in ten thousand (1×10^{-4}), the risk is considered unacceptable.

c. If the incremental cancer risk is between one in one million and one in ten thousand, the risk is evaluated on a case-by-case basis.

2.2.4.2 Noncarcinogens

Public health risk estimates for inhalation of noncarcinogens are based on the following calculation:

$$\textbf{Hazard Quotient} = \mathbf{C/RfC}$$

where:
C = maximum ambient air concentration, $\mu g/m^3$
RfC = pollutant-specific reference concentration, $\mu g/m^3$

The averaging time for noncarcinogen concentrations can be either annual, 24 hours, or 1 hour, depending on the basis of the reference dose (see Appendix A, Table 2).

For routes of exposure other than inhalation, the hazard quotient is calculated by dividing the chemical dose (in mg/kg/day) by the pollutant-specific reference dose (in mg/kg/day).

Hazard quotients are summed separately for inhalation and oral exposures, and for different averaging times, to give **hazard indexes**.

For the types of sources discussed in this manual, AQPP has established the following Risk Management policy:

a. If the hazard index for any contaminant evaluated is less than or equal to one, the risk is considered negligible.

b. If the hazard index is greater than one, the risk is evaluated on a case-by-case basis.

3.0 REFINED RISK ASSESSMENT AND PROTOCOL

3.1 Sources Required to Submit a Refined Risk Assessment

The burden of developing a risk assessment generally falls on the applicant for the following specific source categories:

a. Municipal solid waste, sewage sludge and hazardous waste incinerators, regardless of size;

b. Coal-fired power plants and cogeneration units;

c. Sources subject to Prevention of Significant Deterioration (PSD) which emit any of the air toxics listed in Appendix A;

d. Medical, pathological, industrial or commercial waste incinerators, unless the height of the stack is 1.5 times the height of the controlling building (Good Engineering Practice stack height);

e. On-site clean-ups or off-site commercial treatment of hazardous waste if the screening risk assessment shows a cancer risk of greater than one in a million;

f. Sources which must provide dispersion modeling of the impacts from their criteria pollutant emissions, and which also emit any air toxics listed in Appendix A.

In the *AQPP Technical Manual 1002: Guidance on Preparing an Air Quality Modeling Protocol* (NJDEP 1994), Section 2 details which sources need to conduct dispersion modeling of their criteria pollutant emissions.

3.2 Risk Assessment Protocol

Before a risk assessment document is compiled and submitted to NJDEP, a protocol must be submitted to and approved by BAQEv. The protocol must contain a description and discussion of the methodology that will be used in compiling the risk assessment document. The methodology must be organized according to the standard risk assessment steps, listed and described in Section 2.0 above, and Section 3.4 below.

Applicants preparing a risk assessment protocol should be familiar with *Guidelines for Carcinogen Risk Assessment* (USEPA 1986), *Guidelines for Exposure Assessment* (USEPA 1992), IRIS (USEPA 1994a), *HEAST* (USEPA 1994b), and the BAQEv URF and RfC lists that are in Appendix A.

3.3 Air Quality Modeling for Risk Assessments

Almost all refined risk assessments must include air quality dispersion modeling. The air quality dispersion modeling provides estimates of maximum short- and long-term ambient air concentrations used to determine the potential for adverse health effects from inhalation or dermal contact. Air quality modeling can also be used to estimate dry and wet deposition of the contaminant. This information is then used to estimate health effects from the ingestion exposure routes, such as soil, locally-grown produce, and fish.

The risk assessment protocol should document in detail how the applicant proposes to execute the modeling analysis and present the results. In general, refined risk assessments that included air quality modeling should contain the following information in their protocol:

a. **Project description**, including a project overview, facility layout, and emissions and stack parameters;

b. **Project site characteristics**, including a land use analysis; description of the local topography; a Good Engineering Practice (GEP) stack height analysis; and the meteorological data proposed for use in the modeling analysis;

c. **Proposed air quality analysis method**, including the selection of an air quality model and justification for use; the proposed methods for modeling; and, if applicable, the proposed method of calculating deposition;

d. **Presentation of air quality modeling results**, including how maximum air concentrations, air concentrations at sensitive receptors, and deposition values will be presented.

Specific guidance on how to prepare the air quality modeling portion of the protocol can be found in AQPP's Technical Manual 1002 (NJDEP 1994). Though primarily aimed at the modeling of criteria pollutant emissions (those pollutants with federal or state ambient air standards), guidance in this document is also generally applicable to modeling for risk assessments. However, contrary to what is stated in Technical Manual 1002, when performing modeling for risk assessment purposes only (not for evaluation of criteria pollutant impacts) the following guidance applies:

a. Although it is expected that five years of National Weather Service meteorological data be used in the modeling, they do not necessarily have to be the five most recent years;

b. Long-term annual concentrations can be estimated with a 5-year composite STAR deck; and

c. Regardless of public access to the site, no receptors need to be placed on the facility's property.

Special attention should be given to placing receptors in areas considered to be sensitive, such as nearby residences, hospitals, schools, and parks. Also note that the maximum short-term concentration modeled (not highest, second-highest) should be used to calculate the hazard index for compounds with acute health effects (24 hours or less).

Deposition Modeling. Refined risk assessments that include ingestion exposure pathways will require calculation of deposition. Dry deposition is a function of the ambient air concentration (obtained through modeling) and the pollutant's deposition velocity. Among the most important factors affecting deposition velocity are pollutant properties such as the size and density of particles and the solubility, reactivity, and diffusivity of gases; surface roughness; the amount and type of vegetative cover; and meteorological conditions. Supplement C to *Guideline on Air Quality Models* (USEPA 1993) has proposed a revised version of the Industrial Source Complex 2 (ISC2) Model that contains an improved dry deposition algorithm. Other methods of calculating dry deposition include one developed by the California Air Resources Board as outlined in a paper entitled *Deposition Rate Calculations for Air Toxics Source Assessments* (CARB 1987).

Some risk assessments may want to account for both wet and dry deposition in their analysis. Wet deposition is more difficult to quantify. Important parameters include precipitation rate and the pollutant's precipitation scavenging coefficient. USEPA's COMPDEP is one dispersion model capable of simulating both dry and wet deposition. Applicants should contact BAQEv for guidance on how to incorporate wet and dry deposition into their risk assessments.

3.4 Refined Risk Assessment Guidelines

When preparing a refined risk assessment, the following guidelines should be observed. (This replaces "Risk Assessment Guidelines for Large Incinerators and Coal-Burning Facilities Applying for Air Pollution Control Permits," dated November 1993, and applies to all sources that are required to prepare a refined risk assessment.)

3.4.1 Hazard Identification

a. List all **potential contaminants** which may reasonably be expected to be emitted from the facility into the ambient air. Do not include the criteria pollutants, other than lead, since they should be adequately covered by other permit requirements.

b. List the contaminants which will be evaluated in the risk assessment, based on this "potential contaminants" list. All known human carcinogens (U.S. Environmental Protection Agency Group A) listed among the "potential contaminants" should be included. The contaminants listed below should also be included, as indicated. The rationale used in omitting items on the "potential contaminants" list from the risk assessment must be discussed.

c. If the following contaminants are emitted, they must be included in the risk assessment:

Arsenic
Cadmium
Lead
Mercury
Nickel
Polycyclic aromatic hydrocarbons

d. For incinerators, the risk assessment should also include:

Hexavalent chromium
Hydrogen chloride
2,3,7,8-Tetrachloro-dibenzo-*p*-dioxin
Total dioxins and furans (PCDDs and PCDFs)

e. For coal-fired facilities, the risk assessment should also include:

Beryllium
Chromium (trivalent, hexavalent, and total)
Copper
Manganese
Sulfuric acid

f. Depending on the fuel or waste that is being burned, assessment of the following pollutants may also be necessary:

Ammonia	Chloroform
Benzene	Copper
Beryllium	Formaldehyde
Carbon tetrachloride	Polychlorinated biphenyls
Chlorobenzene	Sulfuric acid

g. A brief (2 to 3 paragraph) description of the health effects of each contaminant must be included in an appendix to the risk assessment document, titled "Toxicity Profiles." All references must be listed.

3.4.2 Dose-Response Assessment

a. For inhalation of carcinogens, URFs (not potency slope factors) must be used to calculate the risk. Use BAQEv's list of unit risk factors for inhalation (see Appendix A), which is updated annually.

b. For ingestion of and dermal exposure to carcinogens, use the most recent slope factors from IRIS and *HEAST* where available.

c. For dioxins and furans, use USEPA's latest toxic equivalency factors, which are equivalent to the "International TEFs/89." For information, refer to *Interim Procedures for Estimating Risks Associated with Exposure to Mixtures of CDDs and CDFs and 1989 Update* (USEPA 1989b).

d. For noncarcinogenic effects for inhalation, use BAQEv's list of inhalation reference concentrations (see Appendix A), updated annually.

e. If inhalation RfCs for specific chemicals cannot be found, they may be derived from the literature if adequate toxicity data exist. A recommended methodology can be found in *Interim Methods for Development of Inhalation Reference Concentrations* (USEPA 1990b). RfCs and RfDs developed by the applicant should be submitted to BAQEv for review and approval prior to submittal of the risk assessment document.

f. For noncarcinogenic effects from ingestion and dermal exposures, the most recent verified USEPA RfDs from IRIS or *HEAST* should be used where available. It is AQPP's policy not to use workplace-derived standards to determine safe exposures for the general population.

g. References for all URFs, SFs, RfCs, and RfDs must be given.

h. Present URFs, SFs, RfCs, RfDs, and their references in table form.

3.4.3 Exposure Assessment

a. For most cases, especially incinerators and coal-burning facilities, assume that the facility will be operating 24 hours a day, 365 days a year, for seventy years.

b. If ingestion or dermal exposure pathways must be analyzed, deposition must be modeled (see Section 3.3). For municipal solid waste and commercial hazardous waste incinerators and coal-burning facilities, the soil ingestion exposure route must always be analyzed. In areas with backyard gardens and in rural areas, ingestion of contaminated vegetables should be calculated. In areas with surface water where recreational fishing may take place, exposure through ingestion of contaminated fish should be calculated. Other exposure routes may include drinking water, cow's milk, locally grown meat, and mother's milk. Refer to the *Exposure Factors Handbook* (USEPA 1989a), and *Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions* (USEPA 1990a). Give references for all exposure assumptions.

c. In most refined risk assessments, when evaluating carcinogens it should be assumed that the most exposed individual remains at the point with the maximum annual average concentration for an entire 70-year lifetime.

d. For exposure routes other than inhalation, calculate the dose to the maximum exposed individual in mg/kg/day. Present doses in table form.

e. For ingestion routes, childhood exposures should be considered, particularly for soil ingestion.

f. Note that some RfCs are based on short-term effects, such as fetal development, and therefore must be compared with maximum 24-hour average ambient concentrations. RfCs for a few other pollutants (such as ethylene oxide and hydrogen chloride) are based on acute exposures and must be compared with maximum 1-hour average ambient concentrations. All others must be compared with maximum annual average ambient concentrations.

g. It is assumed that the average body weight for adults is 70 kg, and 25 kg for children.

h. The inhalation rate for an adult is 20 m^3/day.

3.4.4 Risk Characterization

a. Present results of risk calculations and hazard indices in table form.

b. If a person may be exposed to the same contaminant from more than one ingestion pathway, the calculated dose from each pathway may be summed to yield the total dose.

c. Discuss the level of uncertainty in the overall assessment. This should include the uncertainty involved in the estimation of individual parameters such as emission rates, levels of exposure, and health effects, as well as the implications of complex uncertainties. Parts of this discussion may be placed in the text of steps I, II, and III in order to give some perspective on the significance of the assumptions made in each of those steps. This discussion should then be summarized in the Risk Characterization section.

d. For carcinogens, express risk in terms of incremental individual risk. Do not calculate total population risk. It is not necessary to add the risks from the different contaminants which are being considered.

e. For noncarcinogens, calculate a hazard index for each contaminant and each pathway (see Section 2.3.4.2).

f. The hazard index table must include all of the information used in the calculation (ambient concentration and RfC; or daily dose and RfD). A brief discussion of the relationship between the two sets of numbers should be included in the text.

3.5 Submittal

Risk assessment protocols should be sent to:

Chief, Bureau of Air Quality Evaluation
New Jersey Department of Environmental Protection
Air Quality Permitting Program
CN 027
401 East State Street, 2nd Floor
Trenton, NJ 08625-0027

Telephone: 609-633-1110

4.0 RISK SCREENING

4.1 Sources Subject to Risk Screening

Instead of a refined risk assessment, risk screening is carried out in-house for the following sources:

a. **New and modified sources** that emit any of the contaminants on the risk screening worksheet in Appendix B, and are not required to do a refined risk assessment;

b. **Batch operations** that emit greater than a *de minimis* level of air toxics in the categories listed in the AQPP Bureau of New Source Review (BNSR) "Batch Production Plant Permit Procedure" (NJDEP 1991a) (see Appendix C).

c. **Pilot plants** that emit greater than a *de minimis* level of air toxics in the categories listed in the AQPP BNSR "Pilot Plant Permit Procedure" (NJDEP 1991b) (see Appendix D).

4.2 Overview of Risk Screening

Risk screening methods developed by AQPP consist of two levels.

The **first-level risk screening** procedure is based on information provided on the permit application. It uses generalized worst-case assumptions and simple worksheet calculations to estimate cancer and noncancer risks from inhalation. In place of dispersion modeling, nomographs are used to estimate dispersion and dilution of emitted pollutants and resulting ambient air concentrations. The screening process is designed to minimize the likelihood of incorrectly approving sources that pose a significant health risk. It is designed to overestimate the risk for most sources. This ensures that any source which needs closer scrutiny will be identified. Because the procedure is quick and uncomplicated, it also allows NJDEP to examine the risk at many more sources than would be possible if a refined risk assessment was required for each one.

Sources which fail the first-level screening go on to a second-level screening. A **second-level risk screening** uses additional source-specific parameters along with a computerized mathematical dispersion model to predict risk more accurately. Sources which fail this second-level screening are referred to the AQPP Risk Management Committee for a final case-by-case review and recommendation regarding permitting of the source.

4.3 First-Level Risk Screening

Risk screening worksheets for first-level screening can be found in Appendices B, C (Batch Plant Procedures), and D (Pilot Plant Procedures). These worksheets are, for the most part, self-explanatory. However, some of the details associated with their use are described below for reference purposes.

4.3.1 Hazard Identification

When received by AQPP, all air permit applications are briefly reviewed and categorized by source type before being passed on to the appropriate group of permit evaluators. This preliminary review includes risk screening. If any contaminants listed on the permit application are also listed on the risk screening worksheet, the worksheet is filled out and the risk is calculated.

4.3.2 Dose-Response Assessment

Risk screening worksheets contain Chemical Abstract Service (CAS) numbers for accurate identification of contaminants, and contaminant-specific inhalation URFs or RfCs, taken from NJDEP's compilations.

4.3.3 Exposure Assessment

The risk screening procedure considers only inhalation exposure.

For risk screening, instead of modeling every source, ambient air concentrations of emitted pollutants are calculated using nomographs. These nomographs can be found in Appendix E. They were developed by using dispersion models. The assumptions and methodologies that were used to generate the nomographs are discussed in Appendix F. The nomographs provide an estimate of the normalized ambient air concentration [C'], based on emission rate, stack height, and nearest distance to property line. The nomographs to be used with the risk screening procedure described in this manual are:

Nomograph A: Annual Impact for Stack Height 10-30 feet
Nomograph B: Annual Impact for Stack Height Greater Than 30 feet
Nomograph C: 24-hour Impact for Stack Height 10-30 feet
Nomograph D: 24-hour Impact for Stack Height Greater Than 30 feet

The normalized concentration must be multiplied by the emission rate for each contaminant at each source to determine the maximum 24-hour or annual ambient air concentration. Each maximum concentration resulting from the emissions of the individual sources being permitted is added to produce a total facility impact for each pollutant and each averaging time. It is assumed that operations are at the maximum allowable for a year, day, or hour. It is also assumed that the receptor is exposed to this ambient concentration all the time. For carcinogens, the averaging time is annual. For noncarcinogens, the averaging time for a contaminant (annual, 24 hours, or 1 hour) is based on the health endpoint and averaging time used in developing its reference concentration.

4.3.3.1 Long-term Effects

For long-term effects from carcinogens and noncarcinogens, the maximum annual emission rate [Q] in tons/year must be used to determine [C], the **maximum annual average air concentration**:

$$C = C' \times Q$$

where:
C = maximum annual average air concentration, $\mu g/m^3$
C' = normalized annual air concentration, $(\mu g/m^3)/(ton/yr)$
Q = maximum annual emission rate, ton/yr

4.3.3.2 Short-term Effects

For short-term and acute effects from noncarcinogens, the pound/hour emission rate [Q_h] must be used to determine the **maximum 24-hour average air concentration** [C_{24}].

$$C_{24} = C'_{24} \times Q_h$$

where:
C_{24} = maximum 24-hour average air concentration, $\mu g/m^3$
C'_{24} = normalized 24-hour air concentration, $(\mu g/m^3)/(lb/hr)$
Q_h = maximum hourly emission rate, lb/hr

4.3.3.3 Acute Effects

For acute effects from noncarcinogens, the **maximum one-hour average air concentration** [C_h] is derived from the maximum 24-hour average air concentration:

$$C_h = C_{24} / 0.4$$

where:
C_h = maximum 1-hour average air concentration, $\mu g/m^3$
C_{24} = maximum 24-hour average air concentration, $\mu g/m^3$

4.3.4 Risk Characterization

4.3.4.1 Carcinogens

Multiply the maximum annual average ambient concentration by the unit risk factor to get the incremental risk from each chemical. Total risks for all pollutants.

4.3.4.2 Noncarcinogens

Divide the appropriate ambient concentration by the reference concentration to get the hazard quotient for each chemical. Add those with the same averaging time to get the hazard index.

4.4 Second-Level Risk Screening

If a source fails the risk assessment screening by exceeding the risk guidelines described in Section 2.2.4, the permit evaluator may reexamine the permit application to see if emission rates or operating hours have been overestimated. This reexamination may involve a discussion with the applicant and may result in a modification of the permit application.

If conditions on the permit application are not changed as a result of this review, then BAQEv carries out a more refined analysis to more accurately estimate ambient air concentrations, and to assess the effect of aerodynamic downwash on plume dispersion. This analysis takes into account actual site conditions and source parameters. The applicant is not required to do the modeling, but must provide a detailed plot plan of the site with the following information:

a. Drawn to scale;

b. The location of: all proposed emission points (stacks, vents, etc.); all buildings and structures on-site; and the facility property line;

c. Location of buildings and structures emmediatly adjscent to the applicant's property, if they are located near the proposed emission points;

d. Height, width, and length of all buildings and structures;

e. An indication of true north. (If plant north is shown on the plot plan, the relationship between true north and plant north must be provided.)

In place of a plot plan, the applicant may instead provide GEP stack height calculations according to the Code of Federal Regulations (CFR) 40 Part 51.100. Calculations and supporting information must be included.

With this information BAQEv conducts air quality dispersion modeling of the source using representative meteorological data.

4.5 Risk Management Committee Review

If a source fails the second-level screening, the permit application and air quality dispersion modeling results are forwarded to a Risk Management Committee, which evaluates the application to determine whether and/or how the source's permit should be approved.

5.0 REFERENCES

California Air Resources Board (CARB) 1987. *Deposition Rate Calculations for Air Toxics Source Assessments*. Sacramento, CA.

Code of Federal Regulations (CFR) 1990. Title 40, Part 52. Prevention of Significant Deterioration.

National Research Council (NRC) 1983. *Risk Assessment in the Federal Government: Managing the Process*. National Academy Press, Washington, D.C.

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N.J.A.C. 7:27-17. Control and Prohibition of Air Pollution by Toxic Substances.

N.J.A.C. 7:27-18. Control and Prohibition of Air Pollution from New or Altered Sources Affecting Ambient Air Quality.

NJDEP 1991a. Batch Production Plant Permit Procedure. AQPP Bureau of New Source Review (BNSR), Trenton, NJ.

NJDEP 1991b. Pilot Plant Permit Procedure. AQPP, BNSR, Trenton, NJ.

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USEPA 1989a. *Exposure Factors Handbook*. EPA/600/8-89/043. Office of Health and Environmental Assessment, Washington, D.C.

USEPA 1989b. *Interim Procedures for Estimating Risks Associated with Exposure to Mixtures of CDDs and CDFs and 1989 Update*. EPA/625/3-89/016. Risk Assessment Forum, Washington, D.C.

USEPA 1990a. *Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions*. EPA/600/6-90/003. Office of Health and Environmental Assessment, Washington, D.C.

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USEPA 1991a. Risk Assessment for Air Pollutants: A Citizen's Guide. EPA-450/3-90-024. Air Risk Information Support Center, Research Triangle Park, NC.

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USEPA 1992. Guidelines for Exposure Assessment. *Federal Register*, Vol. 57, No. 104 (5/29/92).

USEPA 1993. *Guideline on Air Quality Models (Revised)*. EPA-450/2-78-027R-B. Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

USEPA 1994a. Integrated Risk Information System (IRIS). IRIS User Support Unit, Cincinnati, OH.

USEPA 1994b. *Health Effects Assessment Summary Tables (HEAST)* - Annual Update. EPA-540-R-93-058. Office of Solid Waste and Emergency Response, Washington, D.C.

APPENDIX A

Toxicity Factors

Table A-1 - Unit Risk Factors for Inhalation
Updated 1/94

Table A-2 - Reference Concentrations for Inhalation
Updated 1/94

APPENDIX B

Risk Screening Worksheet for Carcinogenic Effects

Revised 11/1/94

APPENDIX C

Risk Assessment Guidelines for Batch Plants

Revised 12/5/94

These guidelines and worksheet are part of the "Batch Production Plant Permit Procedure" (NJDEP 1991a)

APPENDIX D

Risk Assessment Guidelines for Pilot Plants

Revised 12/5/94

These guidelines and worksheet are part of the
"Pilot Plant Permit Procedure"
(NJDEP 1991b)

APPENDIX E

Risk Screening Nomographs

Revised 8/5/94

APPENDIX F

Methodology and Assumptions Used to Generate the Risk Screening Nomographs

APPENDIX G

ABBREVIATIONS

AQPP	Air Quality Permitting Program
BAQEv	Bureau of Air Quality Evaluation
BNSR	Bureau of New Source Review
CFR	Code of Federal Regulations
GEP	Good Engineering Practice (stack height)
HAP	Hazardous Air Pollutant
HEAST	USEPA's *Health Effects Assessment Summary Tables*
IRIS	USEPA's Integrated Risk Information System
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NRC	National Research Council
PSD	Prevention of Significant Deterioration
RfC	Reference concentration
RfD	Reference dose
SF	Slope factor
TXS	Toxic substance (under N.J.A.C. 7:27-17)
URF	Unit risk factor
USEPA	United States Environmental Protection Agency

TABLE A-2

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation

REFERENCE CONCENTRATIONS FOR INHALATION
January 1994

	Chemical	CAS Number	RfC ($\mu g/m^3$)	Reference
*	Acetaldehyde	75-07-0	9.3E+0	IRIS 11/93
	Acetone cyanohydrin	75-86-5	1E+1	HEAST 3/93
*	Acetonitrile	75-05-8	5E+1	HEAST 3/93
*	Acetophenone	98-86-2	2E-2	HEAST 3/92
*	Acrolein	107-02-8	2E-2	IRIS 11/93
*	Acrylic acid	79-10-7	3E-1	IRIS 11/93
*	Acrylonitrile	107-13-1	2E+0	IRIS 11/93
*	Allyl chloride	107-05-1	1E+0	IRIS 11/93
	Ammonia	7664-41-7	1E+2	IRIS 11/93
*	Aniline	62-53-3	1E+0	IRIS 11/93
	Barium	---	5E-1	HEAST 3/93
*	Benzene	71-43-2	1.9E+1 (a)	NESCAUM 89
	Boron (anhydrous borax)	7440-42-8	2E+1	HEAST 3/93
	Boron trifluoride	7637-07-2	7E-1	HEAST 3/93
	Bromomethane	74-83-9	5E+0	IRIS 11/93
*	Carbon disulfide	75-15-0	1E+1 (a)	HEAST 3/93
	Chlorine dioxide	10049-04-4	2E-1	IRIS 11/93
*	2-Chloroacetophenone	532-27-4	3E-2	IRIS 11/93
*	Chlorobenzene	108-90-7	2E+1	HEAST 3/93
	2-Chloro-1,3-butadiene	126-99-8 See Chloroprene		
	Chlorodifluoromethane (HCFC-22)	74-45-6	5E+4 (a)	IRIS 11/93
*	Chloroprene	126-99-8	7E+0	HEAST 3/93
	2-Chloropropane	75-29-6	1E+2	HEAST 3/93
*	Chromium (total)	---	2E-3	HEAST 1/91
	Copper	---	1.3E-1	NJDEP 92
*	Cumene	98-82-8	9E+0	HEAST 3/93
*	1,2-Dibromo-3-chloropropane	96-12-8	2E-1	IRIS 11/93
*	1,2-Dibromoethane	106-93-4	2E-1	HEAST 3/93
	1,2-Dichlorobenzene	95-50-1	2E+2	HEAST 3/93
*	1,4-Dichlorobenzene	106-46-7	8E+2	HEAST 3/93
	Dichlorodifluoromethane	75-71-8	2E+2	HEAST 3/93
	1,1-Dichloroethane	75-34-3	5E+2	HEAST 3/93
	Dichloromethane	75-09-2 See methylene chloride		
*	1,2-Dichloropropane	78-87-5	4E+0	IRIS 11/93
*	1,3-Dichloropropene	542-75-6	2E+1	IRIS 11/93
	Dicyclopentadiene	77-73-6	2E-1	HEAST 3/93
	Diesel engine emissions	---	5E+0	IRIS 11/93
	Diethylene glycol monobutyl ether	112-34-5	2E+1	HEAST 3/93
*	N,N-Dimethylformamide	68-12-2	3E+1	IRIS 11/93
*	Epichlorohydrin	106-89-8	1E+0	IRIS 11/93
*	1,2-Epoxybutane	106-88-7	2E+1	IRIS 11/93
	2-Ethoxyethanol	110-80-5	2E+2	IRIS 11/93
*	Ethylbenzene	100-41-4	1E+3 (a)	IRIS 11/93
*	Ethyl chloride	75-00-3	1E+4 (a)	IRIS 11/93
	Ethylene dibromide	106-93-4 See 1,2-dibromoethane		
	Ethylene glycol monobutyl ether	111-76-2	2E+1	HEAST 3/93
*	Ethylene oxide	75-21-8	5.5E+2 (b)	USEPA 92
*	Ethylidene dichloride	75-34-3 See 1,1-dichloroethane		
	Furfural	98-01-1	5E+1	HEAST 3/93
	Gasoline	---	1.5E+1	NESCAUM 89
	Glycidaldehyde	765-34-4	1E+0	HEAST 3/93
*	Hexachlorocyclopentadiene	77-47-4	7E-2	HEAST 3/93
*	N-Hexane	110-54-3	2E+2	IRIS 11/93
*	Hydrochloric acid	7647-01-0 See hydrogen chloride		

	Hydrogen chloride	7647-01-0	7E+0	IRIS 11/93
	Hydrogen chloride (b)	7647-01-0	6E+1 (b)	NJDEP 91
	Hydrogen sulfide	7783-06-4	9E-1	IRIS 11/93
*	Lead	---	1E-1 (a)	NJDEP 93
*	Manganese	---	4E-1	IRIS 11/93
*	Mercury (inorganic)	---	3E-1	HEAST 3/93
	Methacrylonitrile	126-98-7	7E-1	HEAST 3/93
	2-Methoxyethanol	109-86-4	2E+1	IRIS 11/93

Inhalation RfCs (cont'd.)

	Chemical	CAS Number	RfC ($\mu g/m^3$)	Reference
*	Methyl bromide	74-83-9	See bromomethane	
	Methylcyclohexane	108-87-2	3E+3	HEAST 3/93
*	Methylene chloride	75-09-2	3E+3	HEAST 3/93
*	Methyl chloroform	71-55-6	See 1,1,1-trichloroethane	
*	Methylene diphenyl diisocyanate	101-68-8	See 4,4'-methylenediphenyl isocyanate	
	4,4'-Methylenediphenyl isocyanate	101-68-8	2E-2	HEAST 3/93
*	Methyl ethyl ketone	78-93-3	1E+3 (a)	IRIS 11/93
*	Methyl isobutyl ketone	108-10-1	8E+1	HEAST 3/93
	Methyl styrene (mixed isomers)	25013-15-4	4E+1	HEAST 3/93
*	Methyl tert butyl ether	1634-04-4	3E+3	IRIS 11/93
	o-Nitroaniline	88-74-4	2E-1	HEAST 7/93
*	Nitrobenzene	98-95-3	2E+0	HEAST 3/93
	Nitrogen dioxide	10102-44-0	4.7E+2 (b)	CARB 9/85
*	2-Nitropropane	79-46-9	2E+1	IRIS 11/93
*	Phosphine	7803-51-2	3E-2	HEAST 3/93
*	Phthalic anhydride	85-44-9	1.2E+2	HEAST 3/93
	Propylene glycol	57-55-6	6E+3	HEAST 1/91
	Propylene glycol monomethyl ether	107-98-2	2E+3	IRIS 11/93
*	Propylene oxide	75-56-9	3E+1	IRIS 11/93
*	Styrene	100-42-5	1E+3	IRIS 11/93
	Sulfuric acid	7664-93-9	7E+1	HEAST 1/91
*	Tetrachloroethylene	127-18-4	8.1E+1	NESCAUM 86
*	Toluene	108-88-3	6.8E+1	NESCAUM 89
*	1,2,4-Trichlorobenzene	87-61-6	9E+0	HEAST 3/93
	1,1,1-Trichloroethane	71-55-6	1E+3	HEAST 3/92
*	Trichloroethylene	79-01-6	3E+2	NESCAUM 88
	Trichlorofluoromethane	75-69-4	7E+2	HEAST 3/93
	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	3E+4	HEAST 3/93
*	Triethylamine	121-44-8	7E+0	IRIS 11/93
*	Vinyl acetate	108-05-4	2E+2	IRIS 11/93
*	Vinyl bromide	593-60-2	3E+0	IRIS 11/93
*	m-Xylene	108-38-3	1.65E+2 (a)	NESCAUM 89
*	o-Xylene	95-47-6	1.65E+2 (a)	NESCAUM 89
*	p-Xylene	106-42-3	1.65E+2 (a)	NESCAUM 89
*	Xylenes (mixed)	1330-20-7	1.65E+2 (a)	NESCAUM 89
	Zinc/zinc oxide	---	2E-1	NJDEP 92

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* On the 1990 Clean Air Act list of hazardous air pollutants.

All of the reference concentrations are to be compared with long-term (maximum annual average) ambient air concentrations, except those marked as follows:

(a): 24-hour reference concentration, based on maternal, fetal, or developmental effects.
(b): One-hour reference concentration, based on acute exposure.

References

CARB 9/85 - State of California Air Resources Board, Research Division, *Short Term Air Quality Standard for Nitrogen Dioxide*, 9/85.
HEAST 1/91 - USEPA *Health Effects Assessment Summary Tables*, Annual FY-1991, 1/91.
HEAST 3/92 - USEPA *Health Effects Assessment Summary Tables*, Annual Update 1992, 3/92.
HEAST 3/93 - USEPA *Health Effects Assessment Summary Tables*, Annual Update 1993, 3/93.
HEAST 7/93 - USEPA *Health Effects Assessment Summary Tables*, Supplement No. 1 to the March 1993 Annual Update, 7/93.
IRIS 11/93 - USEPA Integrated Risk Information System, as of 11/30/93.
NESCAUM 86 - Northeast States for Coordinated Air Use Management (NESCAUM) Air Toxics Committee, *Health Evaluation Document for Tetrachloroethylene*, 1986.
NESCAUM 88 - NESCAUM Air Toxics Committee, *Health Evaluation Document for Trichloroethylene*, 11/88.
NESCAUM 89 - NESCAUM Air Toxics Committee, *Evaluation of the Health Effects from Exposure to Gasoline and Gasoline Vapors*, 8/89.
NJDEP 91 - Derived by NJDEP Bureau of Air Quality Evaluation.

NJDEP 92 - Derived by NJDEP Bureau of Air Quality Evaluation, based on USEPA *Health Hazard Assessment Summary: Steel Mill Emissions*; Air RISC, Research Triangle Park, NC; EPA 450/3-90-026; 9/90.

NJDEP 93 - Derived by NJDEP Bureau of Air Quality Evaluation, based on USEPA's LEAD5 Model (Lead Uptake/Biokinetic Model) Version 5.

USEPA 92 - *Technical Background Document to Support Rulemaking Pursuant to the Clean Air Act Section 112(g)* (draft); USEPA Office of Air Quality Planning and Standards, Research Triangle Park, NC; EPA-450/3-92-010; 10/28/92.

NJDEP Bureau of Air Quality Evaluation

METHODOLOGY AND ASSUMPTIONS USED TO GENERATE THE RISK SCREENING NOMOGRAPHS FOR POINT SOURCES

(Nomographs dated 8/5/94)

Nomographs A and B (annual impacts) were generated using the Industrial Source Complex Long-Term 2 (ISCLT2) model, Version 93109. Nomographs C and D (24-hour) were generated using the SCREEN2 model, Version 92245.

A. Modeling Assumptions Used to Generate the Nomographs

1. Dispersion models were run in both the rural and urban modes. For each stack height the higher predicted concentration of the two model runs was used in the nomographs. The model was run for the following stack heights: 10 ft, 15 ft, 20 ft, 25 ft, 30 ft, 40 ft, 50 ft, 60 ft, 70 ft, 100 ft, 150 ft, 200 ft, and 300 ft.

2. Point source stack parameters were set to minimize plume rise:
   Exit velocity = 0.001 m/s
   Stack temperature = 293°K (ambient air)
   Stack diameter = 1.0 m

3. The ISCLT2 receptor grid consisted of 16 radials at 22.5-degree intervals, with receptors on the radials every:
   3 m out to 30 m,
   30 m out to 300 m,
   75 m out to 600 m,
   150 m out to 900 m.

   The SCREEN2 runs used the automated receptor distances, with the maximum distance always set beyond the point of maximum impact.

4. Flat terrain was assumed, with no input of receptor elevations.

5. Building downwash was accounted for in all cases:

   a. Building dimensions assumed for stack heights of 30 ft and less:
      Bldg. height = stack height/1.5
      Bldg. projected width = stack height/1.5 (SCREEN2)
      Bldg. projected width = stack height * 0.9 (ISCLT2)

b. Building dimensions assumed for stack heights above 30 ft:
Bldg. height = stack height/2.0
Bldg. projected width = stack height/2.0 (SCREEN2)
Bldg. projected width = stack height * 0.7 (ISCLT2)

6. For ISCLT2, meteorological data used was 1984 through 1988 Newark NWS composite STAR deck.

7. For SCREEN2, meteorological data used was 54 combinations of hourly wind speed and stability (full range of meteorological conditions available in SCREEN2).

8. A factor of 0.4 was used to convert the maximum 1-hour concentrations obtained from the SCREEN2 model runs to 24-hour concentrations.

9. The **normalized annual concentration** obtained from the nomograph should be multiplied by the source's **annual ton per year emission rate**. The result is the source's maximum annual average ground-level concentration.

10. The **normalized 24-hour concentration** obtained from the nomograph should be multiplied by the source's **maximum pound per hour emission rate**. The result is the source's maximum 24-hour average ground-level concentration.

B. Conservatism in the Use of the Risk Screening Nomographs

1. The maximum concentrations for individual sources at a facility are added to produce the total facility impact. This is a conservative assumption because the maximum ground-level impact of sources with differing stack heights and locations will often occur at different locations.

2. The highest impact generated from either the urban or rural mode was used to create the nomographs.

3. No plume rise was assumed.

4. Building downwash effects were always assumed; no GEP stack heights.

5. The maximum allowable pound per hour emission rate must be used to determine the maximum 24-hour average concentration. The source is assumed to operate 24 hours continuously.

NJDEP Air Quality Permitting Program
Bureau of Air Quality Evaluation

Tables of Normalized Concentrations for Use with Risk Screening Worksheets

Note: For stack heights at the higher ends of the ranges presented below, the values in these tables are more conservative than those given in the corresponding nomographs.

TABLE A
From Risk Screening Nomograph A
Annual Impact - Stack Height 10-34 feet

Normalized Annual Concentration ((μg/m^3)/(ton/yr))

Nearest Distance to Property Line (ft)	Stack Height (feet)				
	10-14	15-19	20-24	25-29	30-34
20	180	62	25	12	6.9
30	105	62	25	12	6.9
40	70	45	25	12	6.9
50	50	34	20	12	6.9
60	38	27	17	11	6.9
70	30	22	14	9.4	6.3
80	25	18	12	8.3	5.8
90	21	15	11	7.4	5.3
100	18	13	9.4	6.7	4.8
200	6.6	5.2	3.9	3.1	2.5
300	3.5	2.9	2.5	1.9	1.6
400	2.2	1.9	1.6	1.3	1.1
500	1.5	1.4	1.1	1.0	0.84
600	1.1	1.0	0.87	0.76	0.66
700	0.88	0.80	0.69	0.61	0.54
800	0.70	0.65	0.57	0.51	0.45

TABLE B
From Risk Screening Nomograph B
Annual Impact - Stack Height Greater Than or Equal to 35 Feet

Stack Height (feet)	Normalized Annual Concentration ((μg/m^3)/(ton/yr))
35-39	3.1
40-49	1.7
50-59	0.83
60-69	0.50
70-79	0.33
80-89	0.23
90-99	0.17
100-124	0.13
125-149	0.072
150-174	0.048
175-199	0.032
200-249	0.024

TABLE C
From Risk Screening Nomograph C
24-Hour Impact - Stack Height 10-34 feet

Normalized 24-Hour Concentration ((μg/m^3)/(lb/hr))

Nearest Distance to Property Line (ft)	Stack Height (feet) 10-14	15-19	20-24	25-29	30-34
70	2500	1000	580	380	280
80	2300	1000	580	380	280
90	2100	1000	580	380	280
100	2000	1000	580	380	280
150	1500	860	580	380	280
200	1200	720	490	360	280
300	850	550	380	280	220
400	630	430	310	230	180
500	490	350	260	200	160
600	390	290	220	180	140
700	320	250	190	150	120
800	260	210	170	140	110
900	220	190	150	120	100

TABLE D
From Risk Screening Nomograph D
24-Hour Impact - Stack Height Greater Than or Equal to 35 Feet

Stack Height (feet)	Normalized 24-Hour Concentration ((μg/m^3)/(lb/hr))
35-39	240
40-49	210
50-59	190
60-69	108
70-79	68
80-89	46
90-99	33
100-124	25
125-149	14
150-174	8.3
175-199	5.7
200-249	4.1

RISK ASSESSMENT GUIDELINES FOR BATCH PLANTS

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation (BAQEv)

December 1994

These guidelines and the attached "Screening Risk Assessment Worksheet for Batch Plants" are to be used in conjunction with an application for a special batch plant permit only. They are part of the NJDEP Bureau of New Source Review "Batch Production Plant Permit Procedure" (August 1991).

I. Hazard Identification

* List all contaminants which will be emitted under the following pollutant categories:

Toxic substances (TXS) as listed in
N.J.A.C. 7:27-17
Metals
Vinyl chloride monomer (VCM)
Dioxin
Asbestos

II. Exposure Assessment

A. Estimating Emissions

* For the sake of simplicity, it is permissible to represent all of the emissions within a pollutant category with the most toxic substance in that category. On the Screening Risk Assessment Worksheet for Batch Plants, the substances in each pollutant category are listed separatley for carcinogenic and noncarcinogenic effects in order of potency (with the most toxic substance coming first) in order to expedite this process.

* Alternatively, the emission rate for each individual substance listed on the worksheet may be used, if this information is known.

* For carcinogenic effects, use the ton/year limit for each substance or pollutant category.

* For noncarcinogenic effects, use the emission rate appropriate to the averaging time used to derive the reference concentration. That is, for tetrachloroethylene, trichloroethylene, chromium and mercury, use the ton/year limit. For benzene and lead, use the maximum product average emission rate (lb/hour).

B. Screening Step

* Use the worksheet to calculate the incremental risk and hazard index associated with each substance or pollutant category identified in the Hazard Identification step.

1. Assume that the stack height is that of the shortest stack from which the pollutants will be emitted.

2. For stacks between ten and thirty feet high, determine the nearest distance to property line.

3. Use the appropriate BAQEv risk screening nomographs to estimate the normalized annual air concentration [C'] and the normalized 24-hour air concentration [C'_{24}]:

   Nomograph A - Annual impact for stack height 10 to 30 feet
   Nomograph B - Annual impact for stack height greater than 30 feet
   Nomograph C - 24-hour impact for stack height 10 to 30 feet
   Nomograph D - 24-hour impact for stack height greater than 30 feet

a. <u>Carcinogenic Effects</u>

* For the screening step, assume that all dioxins and furans are 2,3,7,8-TCDD.

* Set the emissions [Q] at the ton/year limit anticipated for the batch operations, as described in section A above. Determine the maximum annual average concentration [C] by multiplying Q by C'.

* Determine the incremental risk [IR] for each pollutant or pollutant category by multiplying its unit risk factor [URF] by the maximum annual average air concentration [C].

* Sum the estimated incremental risks for all contaminants. If the total risk is less than or equal to 1 in 1,000,000 (1×10^{-6}), the carcinogen risk assessment is complete. If the total risk is greater than 1 in 1,000,000, then do the analysis described in section C below.

b. <u>Noncarcinogenic Effects</u>

* For the contaminants in Part C.1 of the worksheet (long-term noncarcinogenic effects), set the emissions [Q] at the ton/year limit, as described in section A above. Determine the maximum annual average air concentration [C] by multiplying Q by C'.

* For the contaminants in Part C.2 of the worksheet (short-term noncarcinogenic effects), set the emissions [Q_h] at the maximum lb/hr product average emission rate, as described in section A above. Determine the maximum 24-hour average air concentration [C_{24}] by multiplying Q_h by C'_{24}.

* Determine the hazard index [HI] for each contaminant by dividing the annual or 24-hour air concentration (C or C_{24}) by the reference concentration [RfC].

* Sum hazard indexes separately for long-term and short-term effects. If both indexes are less than or equal to 1, then the noncarcinogen risk assessment is complete. If a hazard index is greater than 1, then do the analysis described in section C below.

C. Modeling Step

* Standard Gaussian diffusion modeling can be used to estimate exposure. However, the applicant must also consider the potential for downwash of the plume in the wake of the building.

* Use of the ISC2 (Industrial Source Complex 2) dispersion models is recommended. Either ISCLT2 (long-term version) or ISCST2 (short-term version) should be used to estimate annual average concentrations. ISCST2 should be used to estimate maximum 24-hour average concentrations. These models were developed by the U.S. Environmental Protection Agency (USEPA) and are included in the UNAMAP series of USEPA-approved models. Other models may be submitted to BAQEv for approval.

* In order to demonstrate that the models have been used appropriately, the following information should be submitted for the Modeling Step analysis.

    1. Listing of the assumptions made in order to run the model, including the building parameters used for the downwash calculations.

    2. Justification for selection of the meteorological data set.

    3. A copy of the output generated by the model (either a hard copy or diskette).

* The following assumptions should be made:

    1. The emission rates are those defined under "Estimating Emissions" above.

    2. The most exposed individuals remain at the points (off-property) with the maximum annual average and maximum 24-hour average air concentrations for an entire lifetime.

* The incremental risk for carcinogens is calculated by multiplying the unit risk factor by the annual average ambient air concentration. This is explained in more detail in Attachment A. The appropriate unit risk factors can be found in Part B of the worksheet.

* The hazard index for noncarcinogenic effects is calculated by dividing the ambient air concentration (either annual average or 24-hour average) by the appropriate reference concentration (RfC), as identified in the worksheet under Part C.

* For the dioxin pollutant category, either all of the dioxins and furans can be treated as 2,3,7,8-TCDD, or USEPA's Toxic Equivalency Factors may be used.

III. Risk Characterization

* Sources which fail the screening step and go on to the modeling step, as described above, will be evaluated based on the following criteria:

A. Carcinogenic Effects

* Risk for an individual pollutant category which is predicted to be greater than or equal to 1 in 10,000 (1×10^{-4}) is considered unacceptable.

* Risk for an individual pollutant category which is predicted to be less than or equal to 1 in 1,000,000 is considered negligible.

* Risk for an individual pollutant category which is predicted to be between 1 in 10,000 and 1 in 1,000-,000 will be considered on a case-by-case basis by the Air Quality Permitting Program, which will make the final risk management decision.

B. Noncarcinogenic Effects

* If the hazard index for an individual pollutant category is less than or equal to 1, the risk is considered to be negligible.

* Hazard indexes greater than 1 will be evaluated on a case-by-case basis by the Air Quality Permitting Program, which will make the final risk management decision.

Attachment A

ESTIMATING CANCER RISK

Cancer unit risk factors, prepared by the USEPA and other governmental agencies, can be used to estimate the risk posed by long-term exposure to many toxic substances. The unit risk factors are estimates of the additional risk of contracting cancer if a person was exposed to 1 $\mu g/m^3$ of a substance for his or her entire lifetime (assumed to be 70 years). Therefore, the unit risk must be multiplied by the annual average ambient air concentration to determine the health risk for a hypothe-tical person located at the point of maximum impact for his or her entire lifetime. That is:

$$\text{Cancer Risk} = \text{Unit Risk Factor } ((\mu g/m^3)^{-1}) \times \text{Ambient Concentration } (\mu g/m^3)$$

ESTIMATING NONCARCINOGENIC EFFECTS

A reference concentration is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime. Reference concentrations have been developed by USEPA and other governmental agencies. They can be used to estimate the magnitude of the effect of exposure to a noncarcinogenic substance by calculating a hazard index. There should be no appreciable risk if the hazard index is less than 1; that is, if the ambient concentration does not exceed the reference concentration. The equation is:

$$\text{Hazard Index} = \text{Ambient Concentration } (\mu g/m^3) \div \text{Reference Concentration } (\mu g/m^3)$$

SCREENING RISK ASSESSMENT WORKSHEET FOR BATCH PLANTS

PART A: Source Information

A.1. Facility name & no. ____

A.2. Location ____

A.3. Stack height = ______________ feet

A.4. If stack height is less than 30 feet:
Nearest distance to property line = ________________ feet

PART B: Contaminant Information - CARCINOGENIC EFFECTS

B.1. Normalized annual concentration [C'] = ___________________ ($\mu g/m^3$)/(ton/year)
(from Nomograph A or B)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q ($\mu g/m^3$)	Unit Risk Factor [URF] $(\mu g/m^3)^{-1}$	Incremental Risk [IR] = C x URF
TXS					
Ethylene dibromide	106-93-4			2.2E-4	
1,1,2,2-Tetrachloroethane	79-34-5			5.8E-5	
Ethylene dichloride	107-06-2			2.6E-5	
Chloroform	67-66-3			2.3E-5	
1,1,2-Trichloroethane	79-00-5			1.6E-5	
Carbon tetrachloride	56-23-5			1.5E-5	
Tetrachloroethylene	127-18-4			1.4E-5	
Trichloroethylene	79-01-6			1.0E-5	
Benzene	71-43-2			8.3E-6	
1,4-Dioxane	123-91-1			3.1E-6	
Methylene chloride	75-09-2			4.7E-7	
			Total risk -	TXS	

TOTAL RISK THIS PAGE = ________________

SCREENING RISK ASSESSMENT WORKSHEET FOR BATCH PLANTS

PART B: CONTINUED (Contaminant Information - Carcinogenic Effects)

B.1. (From previous page) [C'] = ______________________ ($\mu g/m^3$)/(ton/year)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q ($\mu g/m^3$)	Unit Risk Factor [URF] $(\mu g/m^3)^{-1}$	Incremental Risk [IR] = C x URF
METALS					
Chromium^{+6}	---			1.2E-2	
Arsenic	---			4.3E-3	
Cadmium	---			3.5E-3	
Beryllium	---			2.4E-3	
Nickel	---			4.8E-4	
			Total risk -	Metals	
VCM					
Vinyl chloride	75-01-4			8.4E-5	
DIOXIN					
2,3,7,8-TCDD	1746-01-6			33	
ASBESTOS					
Asbestos	1332-21-4			6.9	

TOTAL RISK BOTH PAGES = __________________

PART C: Contaminant Information - NONCARCINOGENIC EFFECTS

C.1. Long-term Noncarcinogenic Effects

C.1.1. (See B.1.) Normalized annual concentration [C'] = __________________ (μg/m^3)/(ton/year)
(from Nomograph A or B)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q (μg/m^3)	Reference Concentration [RfC] (μg/m^3)	Hazard Index [HI] = C ÷ RfC
TXS					
Methyl chloroform	71-55-6			1000	
			Total HI -	TXS	
METALS					
Chromium (total)	---			0.002	
Mercury	---			0.3	
			Total HI -	Metals	

TOTAL LONG-TERM HAZARD INDEX = __________________

C.2. Short-term Noncarcinogenic Effects

C.2.1. Normalized 24-hour concentration [C'_{24}] = _______________________ (μg/m^3)/(lb/hour)
(from Nomograph C or D)

SUBSTANCE	CAS Number	Product Average Emissions [Q_h] (lb/hr)	Maximum Concentration [C_{24}] = C'_{24} x Q_h (μg/m^3)	Reference Concentration [RfC] (μg/m^3)	Hazard Index [HI] = C_{24} ÷ RfC
TXS					
Benzene	71-43-2			19	
METALS					
Lead	---			0.1	

TOTAL SHORT-TERM HAZARD INDEX = ________________

RISK ASSESSMENT GUIDELINES FOR PILOT PLANTS

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation (BAQEv)

December 1994

These guidelines and the attached "Screening Risk Assessment Worksheet for Pilot Plants" are to be used in conjunction with an application for a special batch plant permit only. They are part of the NJDEP Bureau of New Source Review "Pilot Plant Permit Procedure" (September 1991).

I. <u>Hazard Identification</u>

* List all contaminants which will be emitted under the following pollutant categories:

Toxic substances (TXS) as listed in
N.J.A.C. 7:27-17
Metals
Dioxin
Asbestos

II. <u>Exposure Assessment</u>

A. Estimating Emissions

* For the sake of simplicity, it is permissible to represent all of the emissions within a pollutant category with the most toxic substance in that category. On the Screening Risk Assessment Worksheet for Pilot Plants, the substances in each pollutant category are listed, separately for carcinogenic and noncarcinogenic effects, in order of potency (with the most toxic substance coming first) in order to expedite this process.

* Alternatively, the emission rate for each individual substance listed on the worksheet may be used, if this information is known.

* For carcinogenic effects, use the ton/year limit for each substance or pollutant category.

* For noncarcinogenic effects, use the emission rate appropriate to the averaging time used to derive the reference concentration. That is, for mercury, use the ton/year limit. For lead, use the maximum lb/hour limit.

B. Screening Step

* Use the worksheet to calculate the incremental risk and hazard index associated with each substance or pollutant category identified in the Hazard Identification step.

1. Assume that the stack height is that of the shortest stack from which the pollutants will be emitted.

2. For stacks between ten and thirty feet high, determine the nearest distance to property line.

3. Use the appropriate BAQEv risk screening nomographs to estimate the normalized annual concentration [C'] and the normalized 24-hour concentration [C'_{24}]:

   Nomograph A - Annual impact for stack height 10 to 30 feet
   Nomograph B - Annual impact for stack height greater than 30 feet
   Nomograph C - 24-hour impact for stack height 10 to 30 feet
   Nomograph D - 24-hour impact for stack height greater than 30 feet

a. Carcinogenic Effects

* For the screening step, assume that all dioxins and furans are 2,3,7,8-TCDD.

* Set the emissions [Q] at the limit anticipated for the pilot plant, as described in section A above. Determine the maximum annual average concentration [C] by multiplying Q by C'.

* Determine the incremental risk [IR] for each pollutant or pollutant category by multiplying its unit risk factor [URF] by the maximum annual average concentration [C].

* Sum the estimated incremental risks for all contaminants. If the total risk is less than or equal to 1 in 1,000,000 (1×10^{-6}), then the carcinogen risk assessment is complete. If the total risk is greater than 1 in 1,000,000, then do the analysis described in section C below.

b. Noncarcinogenic Effects

* For methyl chloroform and mercury (long-term effects), set the emissions [Q] at the limit, as described in section A above. Determine the maximum annual average air concentration [C] by multiplying Q by C'.

* For lead (short-term effects), set the emissions [Q_h] at the maximum lb/hour rate, as described in section A above. Determine the maximum 24-hour average air concentration [C_{24}] by multiplying Q_h by C'_{24}.

* Determine the hazard index [HI] for each contaminant by dividing the annual or 24-hour air concentration [C or C_{24}] by the reference concentration [RfC]. Sum the hazard indexes for long-term effects.

* If the hazard index for either long-term or short-term effects is less than or equal to 1, then the noncarcinogen risk assessment is complete. If the hazard index is greater than 1, then do the analysis described in section C below.

C. Modeling Step

* Standard Gaussian diffusion modeling can be used to estimate exposure. However, the applicant must also consider the potential for downwash of the plume in the wake of the building.

* Use of the ISC2 (Industrial Source Complex) dispersion models is recommended. Either ISCLT2 (long-term version) or ISCST2 (short-term version) should be used to estimate annual average concentrations. ISCST2 should be used to estimate maximum 24-hour average concentrations. These models were developed by the U.S. Environmental Protection Agency (USEPA) and are included in the UNAMAP series of USEPA-approved models. Other models may be submitted to BAQEv for approval.

* In order to demonstrate that the models have been used appropriately, the following information should be submitted for the Modeling Step analysis:

1. Listing of the assumptions made in order to run the model, including the building parameters used for the downwash calculations;

2. Justification for selection of the meteorological data set;

3. A copy of the output generated by the model (either a hard copy or diskette).

* The following assumptions should be made:

1. The emission rates are those defined under "Estimating Emissions" above;

2. The most exposed individuals remain at the points (off-property) with the maximum annual average and maximum 24-hour average air concentrations for an entire lifetime.

* The incremental risk for carcinogens is calculated by multiplying the unit risk factor by the annual average ambient air concentration. This is explained in more detail in Attachment A. The appropriate unit risk factors can be found in Part B of the worksheet.

* The hazard index for noncarcinogenic effects is calculated by dividing the ambient air concentration (either annual average or 24-hour average) by the appropriate reference concentration (RfC), as identified in the worksheet under Part C for noncarcinogenic effects.

* For the dioxin pollutant category, either all of the dioxins and furans can be treated as 2,3,7,8-TCDD, or USEPA's Toxic Equivalency Factors may be used.

III. <u>Risk Characterization</u>

* Sources which fail the screening step and go on to the modeling step, as described above, will be evaluated based on the following criteria:

A. Carcinogenic Effects

* Risk for an individual pollutant category which is predicted to be greater than or equal to 1 in 10,000 (1×10^{-4}) is considered unacceptable.

* Risk for an individual pollutant category which is predicted to be less than or equal to 1 in 1,000,000 is considered negligible.

* Risk for an individual pollutant category which is predicted to be between 1 in 10,000 and 1 in 1,000-,000 will be considered on a case-by-case basis by the Air Quality Permitting Program, which will make the final risk management decision.

B. Noncarcinogenic Effects

* If the hazard index for an individual pollutant category is less than or equal to 1, the risk is considered to be negligible.

* Hazard indexes greater than 1 will be evaluated on a case-by-case basis by the Air Quality Permitting Program, which will make the final risk management decision.

Attachment A

ESTIMATING CANCER RISK

Cancer unit risk factors, prepared by the USEPA and other governmental agencies, can be used to estimate the risk posed by long-term exposure to many toxic substances. The unit risk factors are estimates of the additional risk of contracting cancer if a person was exposed to 1 $\mu g/m^3$ of a substance for his or her entire lifetime (assumed to be 70 years). Therefore, the unit risk must be multiplied by the annual average ambient air concentration to determine the health risk for a hypothe-tical person located at the point of maximum impact for his or her entire lifetime. That is:

$$\text{Camcer Risk} = \text{Unit Risk Factor } ((\mu g/m^3)^{-1}) \times \text{Ambient Concentration } (\mu g/m^3)$$

ESTIMATING NONCARCINOGENIC EFFECTS

A reference concentration is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime. Reference concentrations have been developed by USEPA and other governmental agencies. They can be used to estimate the magnitude of the effect of exposure to a noncarcinogenic substance by calculating a hazard index. There should be no appreciable risk if the hazard index is less than 1; that is, if the ambient concentration does not exceed the reference concentration. The equation is:

$$\text{Hazard Index} = \text{Ambient Concentration } (\mu g/m^3) \div \text{Reference Concentration } (\mu g/m^3)$$

SCREENING RISK ASSESSMENT WORKSHEET FOR PILOT PLANTS

PART A: Source Information

A.1. Facility name & no. ____________________

A.2. Location ____________________

A.3. Stack height = ______________ feet

A.4. If stack height is less than 30 feet:
Nearest distance to property line = ________________ feet

PART B: Contaminant Information - CARCINOGENIC EFFECTS

B.1. Normalized annual concentration [C'] = ______________________ ($\mu g/m^3$)/(ton/year)
(from Nomograph A or B)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q ($\mu g/m^3$)	Unit Risk Factor [URF] $(\mu g/m^3)^{-1}$	Incremental Risk [IR] = C x URF
TXS					
Ethylene dibromide	106-93-4			2.2E-4	
1,1,2,2-Tetrachloroethane	79-34-5			5.8E-5	
Ethylene dichloride	107-06-2			2.6E-5	
Chloroform	67-66-3			2.3E-5	
1,1,2-Trichloroethane	79-00-5			1.6E-5	
Carbon tetrachloride	56-23-5			1.5E-5	
Tetrachloroethylene	127-18-4			1.4E-5	
Trichloroethylene	79-01-6			1.0E-5	
Benzene	71-43-2			8.3E-6	
1,4-Dioxane	123-91-1			3.1E-6	
Methylene chloride	75-09-2			4.7E-7	
			Total risk -	TXS	

TOTAL RISK THIS PAGE = __________________

SCREENING RISK ASSESSMENT WORKSHEET FOR PILOT PLANTS

PART B: CONTINUED (Contaminant Information - Carcinogenic Effects)

B.1. (From previous page) [C'] = ______________________ (μg/m^3)/(ton/year)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q (μg/m^3)	Unit Risk Factor [URF] (μg/m^3)$^{-1}$	Incremental Risk [IR] = C x URF
METALS					
Chromium^{+6}	---			1.2E-2	
Arsenic	---			4.3E-3	
Cadmium	---			3.5E-3	
Beryllium	---			2.4E-3	
Nickel	---			4.8E-4	
			Total risk -	metals	
DIOXIN					
2,4,7,8-TCDD	1746-01-6			33	
ASBESTOS					
Asbestos	1332-21-4			6.9	

TOTAL RISK BOTH PAGES = ____________________

PART C: Contaminant Information - NONCARCINOGENIC EFFECTS

C.1. Long-Term Noncarcinogenic Effects

C.1.1. (See B.1.) Normalized annual concentration [C'] = ____________________ (μg/m^3)/(ton/year)
(from Nomograph A or B)

SUBSTANCE	CAS Number	Annual Average Emissions [Q] (ton/yr)	Maximum Concentration [C] = C' x Q (μg/m^3)	Reference Concentration [RfC] (μg/m^3)	Hazard Index [HI] = C ÷ RfC
TXS					
Methyl chloroform	71-55-6			1000	
METALS					
Mercury	---			0.3	

TOTAL LONG-TERM HAZARD INDEX = ________________________

C.2. Short-Term Noncarcinogenic Effects

C.2.1. Normalized 24-hour concentration [C'_{24}] = __________________________ (μg/m^3)/(lb/hour)
(from Nomograph C or D)

SUBSTANCE	CAS Number	Maximum Hourly Emissions [Q_h] (lb/hr)	Maximum Concentration [C_{24}] = C'_{24} x Q_h (μg/m^3)	Reference Concentration [RfC] (μg/m^3)	Hazard Index [HI] = C_{24} ÷ RfC
METALS					
Lead	---			0.1	

RISK SCREENING WORKSHEET FOR NEW AND MODIFIED SOURCES - CARCINOGENS

New Jersey Department of Environmental Protection
Air Quality Permitting Program

November 1994

Note: This worksheet should not be used for sources without stacks, such as some dry cleaners, some degreasers, storage tanks, and gasoline stations.

EVALUATOR ____ DATE _____________________

PART A: Source Information

1. NSR Log No. _______________________
2. Facility name ____
3. Facility location ____
4. Nature of business ____
5. Source category ____
6. Type of control apparatus on source _________________________________ (N/A if none)
7. Control efficiency = ______________%
8. Operating hours per day = ______; per year = _________
9. Discharge direction _____________
10. Stack diameter = _______________inches
11. Temperature = __________°F
12. ACFM = ________________
13. Distance to nearest property line = __________feet
14. Stack height = _______________feet

To determine [C'] for item 15 below: If stack height is between 10 and 30 feet, use Nomograph A.
If stack height is greater than 30 feet, use Nomograph B.

15. Normalized annual concentration [C'] = _______________($\mu g/m^3$)/(ton/yr)

RISK SCREENING WORKSHEET FOR NEW & MODIFIED SOURCES - CARCINOGENS
Facility name ____
NSR log no. _________________________
[C'] = ____________________________ ($\mu g/m^3$)/(ton/yr) (from page 1)

PART B: Contaminant Information

SUBSTANCE	CAS Number	Emissions [Q] (ton/yr)	Concentration [C] = C' x Q ($\mu g/m^3$)	Unit Risk Factor [URF] $(\mu g/m^3)^{-1}$	Incremental Risk [IR] = C x URF
ACETALDEHYDE	75-07-0			2.2E-6	
ACRYLAMIDE	79-06-1			1.3E-3	
ACRYLONITRILE	107-13-1			6.8E-5	
ALLYL CHLORIDE	107-05-1			5.5E-8	
ARSENIC	---			4.3E-3	
ASBESTOS	1332-21-4			6.9E+0	
BENZENE	71-43-2			8.3E-6	
BENZIDINE	92-87-5			6.7E-2	
BENZO(A)PYRENE	50-32-8			1.7E-3	
BENZYL CHLORIDE	100-44-7			1.2E-5	
BERYLLIUM	---			2.4E-3	
BIS(2-CHLOROETHYL)ETHER	111-44-4			3.3E-4	
BIS(CHLOROMETHYL)ETHER	542-88-1			6.2E-2	
1,3-BUTADIENE	106-99-0			2.8E-4	
CADMIUM	---			3.5E-3	
CARBON TETRACHLORIDE	56-23-5			1.5E-5	
CHLORDANE	57-74-9			3.7E-4	
CHLOROFORM	67-66-3			2.3E-5	
CHROMIUM (VI)	---			1.2E-2	
1,2-DICHLOROPROPANE	78-87-5			7.2E-7	
1,4-DIOXANE	123-91-1			3.1E-6	
1,2-DIPHENYLHYDRAZINE	122-66-7			2.2E-4	
EPICHLOROHYDRIN	106-89-8			1.2E-6	
ETHYL ACRYLATE	140-88-5			5.0E-7	
ETHYLENE DIBROMIDE	106-93-4			2.2E-4	
ETHYLENE DICHLORIDE	107-06-2			2.6E-5	
ETHYLENE OXIDE	75-21-8			1.0E-4	
FORMALDEHYDE	50-00-0			1.3E-5	
HEPTACHLOR	76-44-8			1.3E-3	

TOTAL INCREMENTAL RISK PAGE 1 = ___________

RISK SCREENING WORKSHEET FOR NEW & MODIFIED SOURCES - CARCINOGENS
Facility name ____
NSR log no. _________________________
[C'] = ____________________________ ($\mu g/m^3$)/(ton/yr) (from page 1)

PART B (cont'd):

SUBSTANCE	CAS Number	Emissions [Q] (ton/yr)	Concentration [C] = C' x Q ($\mu g/m^3$)	Unit Risk Factor [URF] $(\mu g/m^3)^{-1}$	Incremental Risk [IR] = C x URF
HEXACHLOROBENZENE	118-74-1			4.6E-4	
HEXACHLOROETHANE	67-72-1			4.0E-6	
HYDRAZINE	302-01-2			4.9E-3	
LINDANE	58-89-9			3.8E-4	
METHYL CHLORIDE	74-87-3			1.8E-6	
METHYLENE CHLORIDE	75-09-2			4.7E-7	
4,4-METHYLENEDIANILINE	101-77-9			2.1E-5	
NICKEL (other than nickel subsulfide)	---			2.4E-4	
NICKEL SUBSULFIDE	---			4.8E-4	
NITROBENZENE	98-95-3			1.2E-7	
2-NITROPROPANE	79-46-9			2.7E-3	
N-NITROSODIMETHYLAMINE	62-75-9			1.4E-2	
N-NITROSO-n-METHYLUREA	684-93-5			8.6E-2	
N-NITROSOMORPHOLINE	59-89-2			2.5E-5	
PENTACHLOROPHENOL	87-86-5			3.9E-7	
POLYCHLORINATED BIPHENYLS	1336-36-3			1.2E-3	
PROPYLENE OXIDE	75-56-9			3.7E-6	
STYRENE	100-42-5			5.7E-7	
2,3,7,8-TCDD (Dioxin)	1746-01-6			3.3E+1	
1,1,2,2-TETRACHLOROETHANE	79-34-5			5.8E-5	
TETRACHLOROETHYLENE	127-18-4			1.4E-5	
TOXAPHENE	8001-35-2			3.2E-4	
1,1,2-TRICHLOROETHANE	79-00-5			1.6E-5	
TRICHLOROETHYLENE	79-01-6			1.0E-5	
2,4,6-TRICHLOROPHENOL	88-06-2			3.1E-6	
VINYL CHLORIDE	75-01-4			8.4E-5	
VINYLIDENE CHLORIDE	75-35-4			5.0E-5	

TOTAL INCREMENTAL RISK PAGE 2 = ___________

PART C: **TOTAL INCREMENTAL RISK BOTH PAGES = ____________**

TABLE A-1

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation

UNIT RISK FACTORS(a) FOR INHALATION
January 1994

	Chemical	CAS Number(b)	Carcin. Class(c)	Unit Risk Factor $(\mu g/m^3)^{-1}$	Reference(d)	
*	Acetaldehyde	75-07-0	B2	2.2E-6	IRIS	11/93
*	Acrylamide	79-06-1	B2	1.3E-3	IRIS	11/93
*	Acrylonitrile	107-13-1	B1	6.8E-5	IRIS	11/93
	Aldrin	309-00-2	B2	4.9E-3	IRIS	11/93
*	Allyl chloride	107-05-1	C	5.5E-8	USEPA	5/85
	Aramite	140-57-8	B2	7.1E-6	IRIS	11/93
*	Arsenic (inorganic)	---	A	4.3E-3	IRIS	11/93
*	Asbestos	1332-21-4	A	6.9E+0 (e)	IRIS	11/93
	Azobenzene	103-33-3	B2	3.1E-5	IRIS	11/93
*	Benzene	71-43-2	A	8.3E-6	IRIS	11/93
*	Benzidine	92-87-5	A	6.7E-2	IRIS	11/93
	Benzo(α)pyrene	50-32-8	B2	1.7E-3	HEAST	3/92
*	Benzyl chloride	100-44-7	B2	1.2E-5	USEPA	5/85
*	Beryllium	---	B2	2.4E-3	IRIS	11/93
	Bis(2-chloroethyl)ether	111-44-4	B2	3.3E-4	IRIS	11/93
	Bis(2-chloroisopropyl)ether	39638-32-9	C	1.0E-5	HEAST	3/93
*	Bis(chloromethyl)ether	542-88-1	A	6.2E-2	IRIS	11/93
	Bromoethene	593-60-2	B2	3.2E-5	HEAST	3/93
*	Bromoform	75-25-2	B2	1.1E-6	IRIS	11/93
*	1,3-Butadiene	106-99-0	B2	2.8E-4	IRIS	11/93
*	Cadmium	---	B1	3.5E-3	USEPA	6/85
*	Carbon tetrachloride	56-23-5	B2	1.5E-5	IRIS	11/93
*	Chlordane	57-74-9	B2	3.7E-4	IRIS	11/93
*	Chlorobenzilate	510-15-6	B2	7.8E-5	HEAST	3/93
*	Chloroform	67-66-3	B2	2.3E-5	IRIS	11/93
	Chloromethane	74-87-3	C	1.8E-6	HEAST	7/93
*	Chromium VI	---	A	1.2E-2	IRIS	11/93
*	Coke oven emissions	8007-45-2	A	6.2E-4	IRIS	11/93
	DDT	50-29-3	B2	9.7E-5	IRIS	11/93
*	1,2-Dibromo-3-chloropropane	96-12-8	B2	6.9E-7	HEAST	3/92
	1,2-Dibromoethane	106-93-4	B2	2.2E-4	IRIS	11/93
	Dibutylnitrosamine	924-16-3	See N-nitrosodi-n-butylamine			
*	3,3'-Dichlorobenzidine	91-94-1	B2	4.8E-4	USEPA	9/86
	1,4-Dichloro-2-butene	764-41-0	B2	2.6E-3	HEAST	3/93
	1,2-Dichloroethane	107-06-2	B2	2.6E-5	IRIS	11/93
	1,1-Dichloroethylene	75-35-4	C	5.0E-5	IRIS	11/93
*	Dichloroethyl ether	111-44-4	See bis(2-chloroethyl)ether			
	Dichloromethane	75-09-2	See methylene chloride			
	1,2-Dichloropropane	78-87-5	B2	7.2E-7	USEPA	5/85
*	1,3-Dichloropropene	542-75-6	B2	3.7E-5	HEAST	3/93
	Dieldrin	60-57-1	B2	4.6E-3	IRIS	11/93
*	Diethanolamine	111-42-2		1.1E-7	USEPA	5/85
	Diethylnitrosamine	55-18-5	See N-nitrosodiethylamine			
*	1,1-Dimethylhydrazine	57-14-7	B2	1.0E-3	HEAST	3/93
	1,2-Dimethylhydrazine	540-73-8	B2	1.1E-2	HEAST	3/92
	Dimethylnitrosamine	62-75-9	See N-nitrosodimethylamine			
*	2,4-Dinitrotoluene	121-14-2	B2	8.9E-5	USEPA	9/86
	N-Dioctylphthalate	117-84-0		1.3E-7	USEPA	5/85
*	1,4-Dioxane	123-91-1	B2	3.1E-6	NJDEP	92
	Dioxin	---	See 2,3,7,8-tetrachlorodibenzo(p)dioxin			
*	1,2-Diphenylhydrazine	122-66-7	B2	2.2E-4	IRIS	11/93
*	Epichlorohydrin	106-89-8	B2	1.2E-6	IRIS	11/93

*	Ethyl acrylate	140-88-5	B2	5.0E-7	USEPA	5/85
	Ethylene	74-85-1		2.7E-6	USEPA	5/85
	Ethylene bromide	106-93-4	See 1,2-dibromoethane			
	Ethylene chloride	107-06-2	See 1,2-dichloroethane			
*	Ethylene dibromide	106-93-4	See 1,2-dibromoethane			
*	Ethylene dichloride	107-06-2	See 1,2-dichloroethane			
*	Ethylene oxide	75-21-8	B1	1.0E-4	HEAST	3/93
*	Formaldehyde	50-00-0	B1	1.3E-5	IRIS	11/93
	Gasoline vapors	---		1.0E-6	NESCAUM	89

Inhalation URFs (cont'd.)

	Chemical	CAS Number(b)	Carcin. Class(c)	Unit Risk Factor ($\mu g/m^3)^{-1}$	Reference(d)	
*	Heptachlor	76-44-8	B2	1.3E-3	IRIS	11/93
	Heptachlor epoxide	1024-57-3	B2	2.6E-3	IRIS	11/93
*	Hexachlorobenzene	118-74-1	B2	4.6E-4	IRIS	11/93
*	Hexachlorobutadiene	87-68-3	C	2.2E-5	IRIS	11/93
	Hexachlorocyclohexane (technical grade)	608-73-1	B2	5.1E-4	IRIS	11/93
	alpha-Hexachlorocyclohexane	319-84-6	B2	1.8E-3	IRIS	11/93
	beta-Hexachlorocyclohexane	319-85-7	C	5.3E-4	IRIS	11/93
	gamma-Hexachlorocyclohexane	58-89-9	B2-C	3.8E-4	USEPA	9/86
*	Hexachloroethane	67-72-1	C	4.0E-6	IRIS	11/93
*	Hydrazine	302-01-2	B2	4.9E-3	IRIS	11/93
	Hydrazine sulfate	10034-93-2	B2	4.9E-3	IRIS	11/93
	4,4-Isopropylidenediphenol	80-05-7		1.4E-6	USEPA	5/85
*	Lindane	58-89-9	See gamma-hexachlorocyclohexane			
	Melamine	108-78-1		4.1E-7	USEPA	5/85
*	Methyl chloride	74-87-3	See chloromethane			
*	Methyl chloroform	71-55-6	See 1,1,1-trichloroethane			
*	4,4'-Methylene bis(2-chloroaniline)	101-14-4	B2	3.7E-5	HEAST	3/93
*	Methylene chloride	75-09-2	B2	4.7E-7	IRIS	11/93
	4,4-Methylenedianiline	101-77-9		2.1E-5	USEPA	5/85
	Methylene dichloride	75-09-2	See methylene chloride			
*	Nickel (refinery dust)	---	A	2.4E-4	IRIS	11/93
*	Nickel subsulfide	12035-72-2	A	4.8E-4	IRIS	11/93
*	Nitrobenzene	98-95-3	D	1.2E-7	USEPA	5/85
*	2-Nitropropane	79-46-9	B2	2.7E-3	HEAST	3/93
	N-Nitrosodi-n-butylamine	924-16-3	B2	1.6E-3	IRIS	11/93
	N-Nitrosodiethylamine	55-18-5	B2	4.3E-2	IRIS	11/93
*	N-Nitrosodimethylamine	62-75-9	B2	1.4E-2	IRIS	11/93
	N-Nitrosodiphenylamine	86-30-6	B2	1.4E-6	USEPA	9/86
	N-Nitroso-n-ethylurea	759-73-9		9.4E-3	USEPA	9/86
*	N-Nitroso-n-methylurea	684-93-5		8.6E-2	USEPA	9/86
*	N-Nitrosomorpholine	59-89-2		2.5E-5	USEPA	5/85
	N-Nitrosopyrrolidine	930-55-2	B2	6.1E-4	IRIS	11/93
*	Pentachlorophenol	87-86-5	B2	3.9E-7	USEPA	5/85
	Perchloroethylene	127-18-4	See tetrachloroethylene			
*	Polychlorinated biphenyls (PCBs)	1336-36-3	B2	1.2E-3	USEPA	5/85
	Polycyclic aromatic hydrocarbons (PAHs)	---	See benzo(α)pyrene			
	Propylene chloride	78-87-5	See 1,2-dichloropropane			
*	Propylene dichloride	78-87-5	See 1,2-dichloropropane			
*	Propylene oxide	75-56-9	B2	3.7E-6	IRIS	11/93
*	Styrene	100-42-5	B2	5.7E-7	HEAST	1/91
	Terephthalic acid	100-21-0		1.8E-8	USEPA	5/85
*	2,3,7,8-Tetrachlorodibenzo(p)dioxin (f)	1746-01-6	B2	3.3E+1	HEAST	3/92
	1,1,1,2-Tetrachloroethane	630-20-6	C	7.4E-6	IRIS	11/93
*	1,1,2,2-Tetrachloroethane	79-34-5	C	5.8E-5	IRIS	11/93
*	Tetrachloroethylene	127-18-4	B2	1.4E-5	NESCAUM	86
*	Toxaphene	8001-35-2	B2	3.2E-4	IRIS	11/93
	1,1,1-Trichloroethane	71-55-6		**		
*	1,1,2-Trichloroethane	79-00-5	C	1.6E-5	IRIS	11/93
*	Trichloroethylene	79-01-6	B2	1.0E-5	NESCAUM	11/88
*	2,4,6-Trichlorophenol	88-06-2	B2	3.1E-6	IRIS	11/93
*	Vinyl bromide	593-60-2	See bromoethene			
*	Vinyl chloride	75-01-4	A	8.4E-5	HEAST	3/93
*	Vinylidene chloride	75-35-4	See 1,1-dichloroethylene			

(a) The unit risk factor is the estimated excess probability of contracting cancer as the result of constant exposure over a 70-year period to an ambient concentration of one microgram per cubic meter.

Inhalation URFs (cont'd.)

(b) CAS Number - Chemical Abstract Service identification number

(c) Carcin. Class - USEPA classification of carcinogenicity

- Group A - Human carcinogen; sufficient evidence of carcinogenicity in humans.
- Group B1 - Probable human carcinogen; limited evidence of carcinogenicity in humans.
- Group B2 - Probable human carcinogen; sufficient evidence of carcinogenicity in animals with inadequate evidence in humans.
- Group C - Possible human carcinogen; limited evidence of carcinogenicity in animals and inadequate human data.
- Group D - Not classifiable as to human carcinogenicity; inadequate or no evidence.

(d) References:

HEAST 1/91 - USEPA *Health Effects Assessment Summary Tables*, Annual FY-1991, Jan. 1991.

HEAST 3/92 - USEPA *Health Effects Assessment Summary Tables*, Annual Update 1992, March 1992.

HEAST 3/93 - USEPA *Health Effects Assessment Summary Tables*, Annual Update 1992, March 1993.

HEAST 7/93 - USEPA *Health Effects Assessment Summary Tables*, Supplement No. 1 to the March 1993 Annual Update, July 1993.

IRIS 11/93 - USEPA Integrated Risk Information System, as of 11/30/93.

NESCAUM 86 - Northeast States for Coordinated Air Use Management (NESCAUM) Air Toxics Committee, *Health Evaluation Document for Tetrachloroethylene*, 1986.

NESCAUM 88 - NESCAUM Air Toxics Committee, *Health Evaluation Document for Trichloroethylene*, Nov. 1988.

NESCAUM 89 - NESCAUM Air Toxics Committee, *Evaluation of the Health Effects from Exposure to Gasoline and Gasoline Vapors*, Aug. 1989.

NJDEP 92 - Derived by NJDEP based on oral slope factor of 1.1E-2 (mg/kg-day)$^{-1}$ (IRIS 11/92), converted using the following equation:

$$[SLOPE,(\frac{mg}{kg\text{ - }day})^{-1}](\frac{1}{70\ kg})(\frac{20\ m^3}{day})(\frac{1\ mg}{1000\ mg}) = URF,(\frac{mg}{m^3})^{-1}$$

USEPA 5/85 -USEPA *The Air Toxics Problem in the United States: An Analysis of Cancer Risks for Selected Pollutants*; Office of Air and Radiation, Washington, D.C.; EPA-450/1-85-001. See Attachment A, Summary Table.

USEPA 6/85 - USEPA *Updated Mutagenicity and Carcinogenicity Assessment of Cadmium - Addendum to the Health Assessment Document for Cadmium* (Final Report); Office of Health and Environmental Assessment, Washington, D.C.; EPA/600/8-83/025F. See Table 26.

USEPA 9/86 - USEPA *Health Assessment Document for Nickel and Nickel Compounds* (Final Report); Office of Health and Environmental Assessment, Washington, D.C.; EPA/600/8-83/012FF. From Table 8-56, converted to a unit risk factor (URF) from an inhalation slope factor using the same equation given under NJDEPE 92.

USEPA 4/88 - USEPA Carcinogen Assessment Group unit risk estimates; compiled by F. Hauchman, USEPA Office of Air Quality Planning and Standards (OAQPS), 4/14/88. Attached to memo from G. Allande, USEPA Region II, to J. Held, NJDEPE, 5/25/88.

(e) The unit risk factor for asbestos is given in IRIS as 2.3E-1 (fibers/ml)$^{-1}$. It has been converted based on a conversion factor of 30 $\mu g/m^3$ = 1 fiber/cm^3 (Table 7-6, *Asbestiform Fibers: Nonoccupational Health Risks*, National Research Council, National Academy Press, Washington, D.C., 1984).

(f) For other chlorinated dibenzo-*p*-dioxins (CDDs) and dibenzofurans (CDFs), see USEPA's *Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of CDDs and CDFs and 1989 Update*, Risk Assessment Forum, EPA/625/3-89/016, March 1989.

* On the 1990 Clean Air Act Amendments list of hazardous air pollutants.

** Carcinogenicity of 1,1,1-trichloroethane may be due to contamination by 1,4-dioxane (IRIS 11/92).

New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Air Quality Evaluation

If a source fails first-level risk screening, the applicant has the option of having the Bureau of Air Quality Evaluation (BAQEv) conduct a second-level risk screening, or of modifying the permit application.

INFORMATION REQUIRED FOR SECOND-LEVEL RISK SCREENING

BAQEv carries out a refined air quality dispersion modeling to more accurately estimate ambient air concentrations, and to assess the effect of aerodynamic downwash on plume dispersion. This analysis takes into account actual site conditions, source parameters, and meteorology. In order to do this, the applicant must provide to BAQEv one of the two items listed below.

1. Detailed plot plan. This is a depiction of the site, drawn to scale with the scale indicated on the plot plan, containing the following information:

   A. Location of: All proposed emission points (stacks, vents, etc.)
   All buildings and structures on-site
   Facility property line

   B. Location of buildings and structures immediately adjacent to the applicant's property, if they are located near the proposed emission points

   C. Height, width, and length of all buildings and structures

   D. An indication of true north. (If plant north is shown on the plot plan, the relationship between true north and plant north must be provided.)

2. GEP Stack Height Analysis. In place of a plot plan, the applicant may instead provide Good Engineering Practice (GEP) stack height calculations according to Code of Federal Regulations 40 Part 51.100. Calculations and supporting information must be included.

Contact BAQEv at 609-633-1110 if specific guidance is needed concerning the plot plan or GEP stack height calculations.

Note that when performing second-level risk screening in-house, BAQEV will also check the risk from noncarcinogens which have reference concentrations* and are listed on the applicant's VEM form.
* See NJDEP Technical Manual 1003, Appendix A, Table A-2.

PERMIT MODIFICATION ALTERNATIVE

As an alternative to BAQEv conducting a second-level risk screening, the permit application may be modified so that the calculated risk (using the screening risk assessment worksheet) is less than or equal to one in a million (1×10^{-6}, or 0.000001). Modifications can include a reduction in emissions, an increase in stack height, or a reduction in operating hours.

The second-level risk screening analysis done by BAQEv may indicate that the air concentration of the emitted pollutant is lower than that predicted by the screening worksheet, resulting in negligible risk (less than or equal to one in a million).

If the risk predicted by BAQEv is not less than or equal to one in a million, the application will go to the Risk Management Committee for review. The Risk Management Committee may recommend that:

1. *The applicant apply better air pollution controls to lower emissions.*

2. *The applicant change stack characteristics for better dispersion to avoid downwash (for example, an increase in stack height).*

3. *A detailed site-specific (refined) risk assessment be done by the applicant or the applicant's consultant.*

Applications with risks greater than 1 in 10,000 (1×10^{-4}, or 0.0001) will be denied.